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Heat Transfer (1)

Modes of Heat transfer

15/3/2016
سكشن ٤ انتقال حرارة
AMR M.

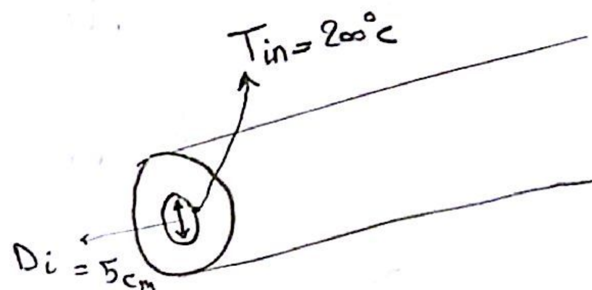
sheet . No. 1

Prob (16) Pipe surrounded by asbestos.

$K_{asb} = 0.17\ W/m°.C$

$T_\infty = 20°C$

$h_o = 3\ W/m^2.°C$

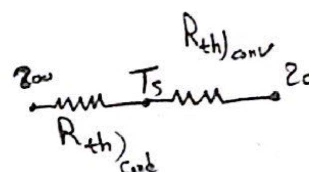


Require

[1] $r_{cr} = ??\ mm$

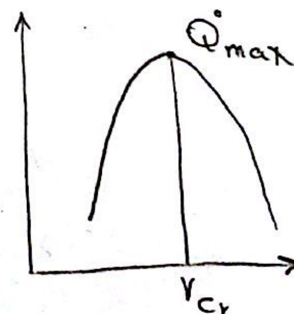
[2] $\dot{Q}_{loss})$ without insulation.

[3] $\dot{Q}_{loss})$ pipe covered with critical radius of insulation.



Solution

* Cylinder (pipe) tube ⟶ $r_{cr} = \frac{K_{ins}}{h_o} = \frac{0.17}{3} = 0.056\ m = 5.6\ cm$



$$\dot{Q}_{with\ insulation} = \frac{\Delta T}{\Sigma R_{th}} = \frac{200 - 20}{\frac{\ln r_{cr}/r_i}{2\pi K_{ins} L} + \frac{1}{h_o * 2\pi r_c * L}}$$

$$q' = \frac{\dot{Q}}{L} = \frac{180}{\frac{\ln 5.6/2.5}{2\pi * 0.17 * 1} + \frac{1}{3 * 2\pi * 0.056}} = 105.73\ \frac{W}{m}$$

[1.]

Case [2]

$$\dot{Q}_{\text{without insulation}} = \frac{\Delta T}{R_{th})_{conv}} = \frac{200 - 20}{\frac{1}{3 * 2\pi * 0.025}} = 84.82 \text{ W/m}.$$

Prob [17] steel pipe ($K_s = 43$ W/m.°C)

D_o pipe = 2.5 cm = 25 mm

wall thickness = 2 mm.

$h_i = 500$ W/m^2.C

$h_o = 12$ W/m^2.C

Calculate "U" the overall heat transfer coefficient.

* If the pipe is covered with asbestos.

$K_{asb} = 0.18$ W/m°.C [and] $h_o = 12$ W/m^2.C

Determine [1] r_{cr}

[2] will the heat transfer be increased or decreased by adding an insulation thickness [a] 5 mm.

[b] 10 mm.

over all heat transfer coefficient "U"

$$\therefore \dot{Q} = \frac{\Delta T}{\sum R_{th}} = U * A * \Delta T$$

$$\therefore UA = \frac{1}{\sum R_{th}} \qquad \therefore U = \frac{1}{A \cdot \sum R_{th}}$$

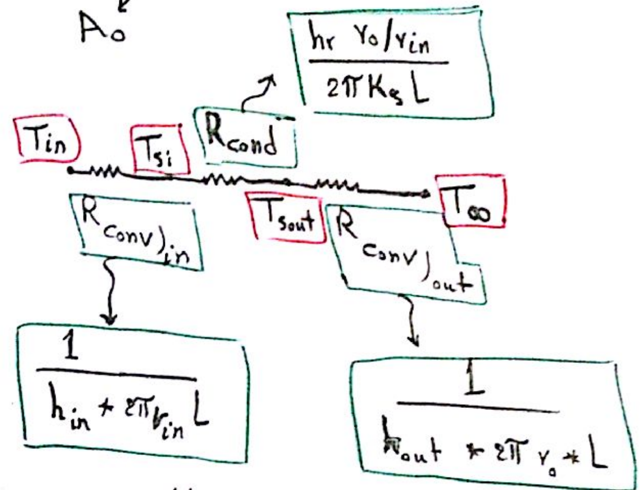


$D_o = 2.5$ cm $= 25$ mm

$r_o = 12.5$ mm

thickness wall $= 2$ mm.

$r_{in} = 12.5 - 2 = 10$ mm



$$\sum R_{th} = \frac{1}{h_i * 2\pi r_i L} + \frac{\ln r_o/r_i}{2\pi K_s L} + \frac{1}{h_o * 2\pi r_o * L} = \checkmark$$

$$U_i = \frac{1}{A_i * \sum R_{th}} = \checkmark \quad , \quad U_o = \frac{1}{A_o * \sum R_{th}} = \checkmark$$

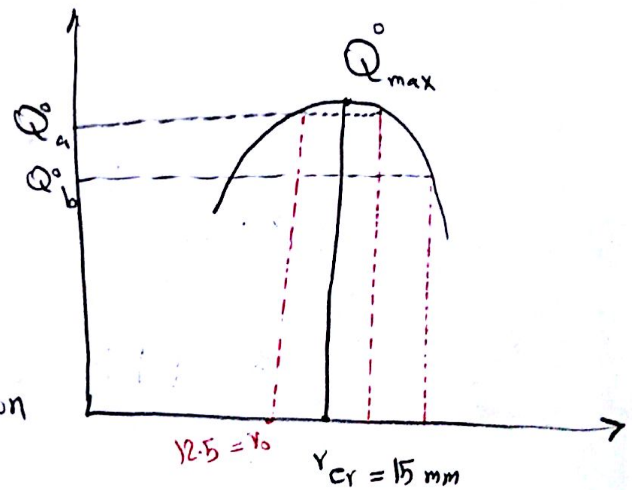
$$r_{cr} = \frac{K_{asb}}{h_o} = \frac{0.18}{12} = 0.015\,m = 15 \text{ mm}$$

[a] thickness δ insulation $= 5$ mm

d

$r_o = 12.5$ mm

$r_{insulation})_a = 12.5 + 5 = 17.5$ mm

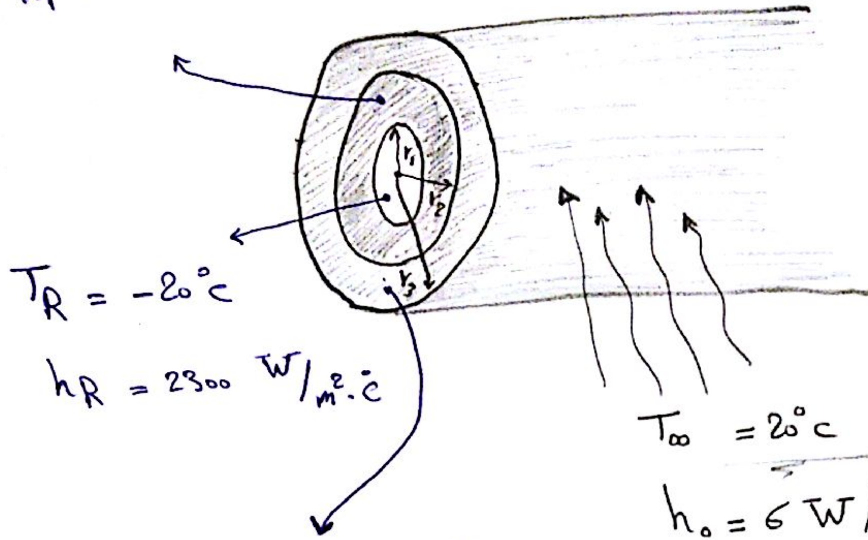


$\dot{Q}_a \cong$ constant and the insulation not effective

$r_{insulation})_b = 12.5 + 10 = 22.5$ mm

$\dot{Q}_b \rightarrow$ is decreased and the insulation will be effective.

$K_p = 58\ W/m^{\circ}.c$ ، $D_i = 50\ mm$ ، $\delta_w = 5\ mm$



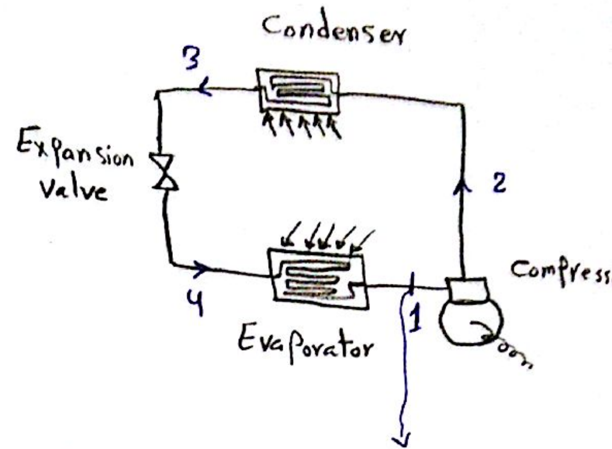
$T_R = -20^{\circ}c$

$h_R = 2300\ W/m^2.^{\circ}c$

$T_\infty = 20^{\circ}c$.

$h_o = 6\ W/m^2.^{\circ}c$.

$K_{in} = 0.042\ W/m^2.c$



suction line
خط السحب

Dew Point Temperature (درجة حرارة قطرة الندى)

$T_{dp} = 15^{\circ}c$

هي درجة الحرارة التي عندها جزء من بخار الماء يتكثف

Required:- δ insulation to prevent water vapour from condensed on the outer surface of tube.

Sol..

$r_3 - r_2 = \delta_{insulation}$



For steady state flow of heat

$\dot{Q}_{air \to outer\ surface} = \dot{Q}_{outer\ surface \to Refrigerant}$

$$\frac{T_\infty - T_{s\,out}}{\frac{1}{h_o * 2\pi r_3 * L}} = \frac{T_{s\,out} - (-20)}{\frac{\ln r_3/r_2}{2\pi k_{ins} * L} + \frac{\ln r_2/r_1}{2\pi K_{pipe} * L} + \frac{1}{h_i * 2\pi r_i * L}}$$

F

Let $T_{s\,out} = 16^\circ c$

by using (Trial and error)

Let $r_3 = 32$ mm ⟶ R.H.S = vv ? L.H.S = vv ☒

$r_3 = 38$ mm ⟶ R.H.S = vv ? L.H.S = vv ☐

⋮

$r_3 =$

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